CLAIMS

1. A method of converting an image into a hologram formed f rom diffraction gratings comprising the steps of :

(a) obtaining data regarding said image according to an X-Y coordinate system to derive position data and corresponding image data for each pixel of a plurality of pixels representing said image;

(b) directing a beam from a laser having a predetermined coherence length onto a photosensitive surface in a sequence corresponding to pixel position data representing said image so as to react with said photosensitive surf ace forming diffraction gratings, said step of directing including the sub-steps of:

(1) splitting the laser beam into a plurality of beam parts;

(2) directing a first beam part of said laser beam as a reference beam to said photosensitive surface along a first pathway;

(3) directing others of said plurality of beam parts along a plurality of other pathways, each of said other pathways being of a length within a range defined by the coherence length of said laser;

(4) modulating said plurality of beam parts in accordance with said data for a selected pixel so that said others of said plurality of beam parts are

modulated separately from said first beam part, modulation of said others of said beam parts being based on image data for said selected pixel, wherein said others of said beam parts are coincidence with said first beam part on the photosensitive surface at different angles with respect to the photosensitive surface for a selected pixel;

(c) serially moving said photosensitive surface with respect to said laser beam so as to redirect the laser beam to a pixel location successive to said selected pixel location on said photosensitive surface in correspondence to said X-Y coordinate system; and

(d) repeating steps (b)-(e) for each successive pixel location so that a pattern is irradiated corresponding to said image.

2. The method of claim 1, wherein the step of obtaining includes scanning said image according to an X-Y coordinate system to derive position data and image data for a plurality of pixels representing said image; and encoding said image data and said position data for each said pixel.

3. The method of claim 1 wherein, said step obtaining data comprises computer-generating said image data and transferring position data and image data for each

of said pixels representing said image.

4. The method of claim 3, wherein a plurality of images are computer generated, and a plurality of patterns are irradiated on said photosensitive surface corresponding to said plurality of images.

5. The method of claim 1, wherein the step of directing said laser beam further comprises the sub-step of diffusing said laser beam and then refocusing said laser beam before splitting said laser beam into a 5 plurality of parts.

6. The method of claim 1, further comprising the step of storing said position data and said image data for said pixels.

7. The method of claim 6, wherein said pixel data is stored for a predetermined time period for the step of directing said laser beam.

8. The method of claim 1, wherein said step of obtaining data further comprises the sub-step of determining a size for at least some of said plurality of said pixels.

9. The method of claim 8, wherein said size of said pixels are adjusted by a predetermined factor before the step of directing said laser beam.

10. The method of claim 1, wherein said remaining beam parts constitute three parts, each representing a primary color data for said selected pixel.

11. The method of claim 10, wherein each said remaining beam part is coincidence with said reference beam part at different times in a predetermined sequence.

12. The method of claim 1, wherein a plurality of said remaining beam parts are simultaneously coincidence on said photosensitive surface with said reference beam part in a predetermined sequence.

13. The method of claim 1, wherein said reference beam is modulated based upon brightness data for said selected pixel.

14. The method of claim 1, wherein said reference beam is modulated based upon optical density on a scale between black and white for said selected pixel.

15. The method of claim 1, further comprising the step of developing said photosensitive surface to form a hologram.

16. The method of claim 1, further comprising the step of storing said encoded data in a memory before the step of directing said laser beam.

17. The method of claim 1. wherein each of said other pathways is of equal length to said first pathway.

18. The method of claim 1, wherein the step of modulating includes interfering more than one of said others of said plurality of beam parts simultaneously with said reference beam.

19. The method of claim 3, wherein said image data is computer-generated using mathematical algorithms.

20. The method of claim 3, wherein said image data is obtained by computer manipulation of previously scanned images.

21. The method of claim 3, wherein said image data is computer-generated using a drawing program operated on a computer.

22. The method of claim 2, wherein said image data is obtained by means of a video camera.

23. The method of claim 2, wherein said image data is obtained by scanning a hologram with a coherent beam of light.

24. The method of claim 2, wherein said image data is obtained by scanning a hologram using a point source of light.

25. The method of claim 1, wherein the sub-step of directing said others of said plurality of beam parts includes the steps of ref lecting said others of said plurality of said beam parts.

26. The method of claim 1, wherein said sub-step of modulating said plurality of beam parts comprises operating shutters.

27. The method of claim 1, wherein the step of directing a beam from a laser comprises the sub-step of rotating an optical apparatus to vary said angles of incidence with respect to the photosensitive surface for others of said plurality of beam parts.

28. The method of claim 1, wherein the step of serially moving said photosensitive surface comprises the sub-steps of:

moving said table in an X direction, and

moving said table in a Y direction.

29. The method of claim 27, wherein each position of said optical apparatus results in a different set of angles of incidence ~~to~~ said photosensitive surface for each of said others of said plurality of beam parts, each set of angles corresponding to a different viewing angle for said resulting hologram.

30. The method of claim 1, wherein said step of serially moving said photosensitive surface comprises rotating a cylinder and translating said cylinder along its longitudinal axis.

31. The method of claim 1, wherein said sub-step of directing said first part of said laser beam comprises the sub-steps of diffusing said reference beam and then refocusing said reference beam before interfering with said others of said plurality of beam parts on said photosensitive surface.

32. The method of claim 29, wherein said optical apparatus is rotationally repositioned a plurality of times for each pixel.

33. The method of claim 1, wherein the step of directing said beam from said laser comprises passing said beam through a limiting aperture.

34. The method of claim 33, wherein said beam is given a predetermined shape by said limiting aperture.

35. The method of claim 34, wherein said laser beam having a predetermined shape is passed through a density filter so as to change said beam from a Gaussian profile to a linear profile.

36. The method of claim 1, wherein said step of directing the beam from said laser further comprises the sub-step of modulating said beam from said laser in and out of phase.

37. The method of claim 1, wherein said step of directing the beam further comprises the sub-step of spatially filtering said beam.

38. The method of claim 1, wherein said method is carried out with a plurality of devices, each configured to carry out said entire method independently, where said plurality of devices carry out said method simultaneously 5 on a single photosensitive surface.

39. The method of claim 1, wherein the step of directing said beam from said laser comprises operating a shutter.

40. The method of claim 1, wherein the step of directing said beam from said laser comprises the sub- step of passing at least one of said plurality of said beam parts through a limiting aperture.

41. The method of claim 40, wherein at least one of said beam parts is given a predetermined shape by said limiting aperture.

42. The method of claim 41, wherein said at least one of said plurality of beam parts having a predetermined shape is passed through a density filter so as to change said beam part from a Gaussian profile to a linear profile.

43. The method of claim 1, wherein at least one of said plurality of beam parts is modulated in and out of phase.

44. The process of claim 1, wherein said reference beam and said others of said beam parts interfere directly on a photosensitive emulsion mounted on a roller.

45. The process of claim 44, further comprising the step of hardening said photosensitive material on said roller.

46. The process of claim 45, further comprising the step of applying said hardened photosensitive material on said roller to a receptive plastic material thereby embossing said receptive plastic material.

47. A method of converting an image into a hologram formed from diffraction gratings, comprising steps of:

(a) obtaining pixel data for said image;

(b) splitting a laser beam having a coherence range suitable for forming holograms into a reference beam and a plurality of object beams;

(c) directing said reference beam and said object beams along different pathways, each pathway having a length within said coherence range;

(d) modulating said plurality of object beams in accordance with said pixel data wherein said object beams are coincidence with said reference beam on a photosensitive surface at different angles with respect to the photosensitive surface for each pixel to form diffraction gratings.

48. The method of claim 47, further comprising the step of (e) serially moving said photosensitive surface with respect to said reference beam so as to redirect said reference beam to successive pixel locations.

49. The method of claim 48, wherein steps (b)-(e) are repeated for each successive pixel location so that a pattern is radiated corresponding to said image.

50. The method of claim 47, wherein said object beams are coincidence with said reference beam in a predetermined sequence.

51. The method of claim 50, wherein only a single object beam is coincidence with said reference beam on said photosensitive surface at one time.

52. The method of claim 50, wherein a plurality of said object beams are coincidence with said reference beam on said photosensitive surface simultaneously.

53. The process of claim 49, wherein said angles of said object beams are adjusted to correspond to an optimum viewing angle for said hologram.

54. The method of claim 53, wherein said method is carried out more than once for selected pixels of sid image.

55. The method of claim 47, wherein the step of obtaining pixel data is carried out by scanning an image.

56. The method of claim 47, wherein said step of obtaining pixel data is carried out by computer-generating data regarding said image.

57. The method of claim 53, wherein said laser beam is adjusted by an optical system, and said optical system is rotated to adjust said angles of said object beams.

58. The method of claim 49, wherein spacing between adjacent pixels is adjusted to determine an extent of image depth perception for said hologram when viewed from an optimum angle.

59. The method of claim 58, wherein said process is repeated a plurality of times at selected pixel locations using different angles for each said object beam for each operation of said method, wherein said image of said hologram alters depending/angles at which the hologram is viewed.

60. An apparatus for converting image data into a hologram formed from diffraction gratings based upon pixels representative of said image, comprising:

(a) means for inputting image data for each pixel representing said

image;

(b) a laser source configured to generate a beam with a coherence length range suitable for forming a hologram;

(c) an optical system arranged to split and direct said laser beam into a reference beam and at least one object beam along pathways having a length within said range of said coherence length;

(d) means for moving said photosensitive surface with respect to said laser beam; and

(e) a controller, said controller comprising:

(i) means for generating control signals to control modulation of said reference and object beams in accordance with image data for each said pixel,

(ii) means for generating control signals to control said positioning of said optical system to adjust an angle of incidence of said reference beam and said object beam on said photosensitive surface so that each object beam is incidence at a different angle to said photosensitive surface to form diffraction gratings, and

(iii) means for generating control signals to control said means for moving said photosensitive surface in accordance with pixel location of said image.

61. The apparatus of claim 60, wherein said means for inputting image data comprise a computer storing data regarding a scanned image.

62. The apparatus of claim 60, wherein said means for inputting image data comprise a computer having a program for generating an image based upon mathematical algorithms.

63. The apparatus of claim 60, wherein said means for inputting image data comprise a computer having a program permitting a user to manually construct an image.

64. The apparatus of claim 60, wherein said optical system comprises a light diffuser and a lens for refocusing diffused light.

65. The apparatus of claim 60, wherein said optical system is mounted on a roller bearing moved by a stepping motor.

66. The apparatus of claim 64, wherein said light diffuser comprises a ground glass screen.

67. The apparatus of claim 60, wherein said optical system further comprises shutters to control said laser beam, and said object beams.

68. The apparatus of claim 60, wherein said means for moving said photosensitive surface comprise a rotating cylinder.

69. The apparatus of claim 60, wherein said means for moving said photosensitive surface comprise an X-Y stage movable along X and Y axes.

70. The apparatus of claim 60, comprising a second laser source and a second optical system arranged so that multiple exposure to interfering reference and object beams can be carried out simultaneously at more than one position on the same photosensitive surface.

71. An apparatus for converting image data into a hologram formed from diffraction gratings based upon pixels representative of said image, comprising:

(a) a laser source configured to generate a beam with a coherence length range suitable for forming a hologram;

(b) focusing lens assembly;

(c) a main shutter arranged to control said laser beam;

(d) optical head means for splitting said laser beam into a reference beam and a plurality of object beams, for redirecting said reference beam and said object beams along different pathways so that each said object beam is incidence on a photosensitive surface with said reference beam at different angles, and for modulating said object beams so that each object beam is coincidence on said photosensitive surface with said reference beam in a predetermined sequence;

(e) photosensitive surface upon which said hologram is formed by interfering light beams;

(f) optical isolation bench to support said apparatus;

(g) optical bridge support mounted on said optical isolation bench and arranged to support said focusing lens assembly and said optical head means;

(h) a plurality of first stepper motors for moving said photosensitive surface along an X axis and a Y axis; (i) a second stepper motor for rotating said optical head means;

(j) central processing means comprising; data input means for providing data for each pixel constituting said image, and

means for correlating said pixel data to operation of said main shutter, optical head means, and first and

second stepper motors;

(k) means for monitoring said hologram as it is generated.

72. The apparatus of claim 71, further comprising interface means between said central control means and each of said main shutter, focusing lens assembly and first and second stepping motors.

73. The apparatus of claim 71, wherein said monitoring means comprise a video camera and a video monitor.

74. The apparatus of claim 71, wherein said data input means comprise a keyboard, and wherein said central processing means includes a program for generating images.

75. The apparatus of claim 71, wherein said data input means comprise a video camera.

76. The apparatus of claim 60, wherein a plurality of object beams interfere with said reference beam on said photosensitive surface in a predetermined sequence to form diffraction gratings.

77. A method of converting an image into a hologram formed from diffraction gratings, comprising the steps of:

(a)obtaining pixel data from said image;

(b) splitting a laser beam having a coherence range suitable for forming holograms into a reference beam and at least one object beam;

(c) directing said reference beam along different pathways, each pathway having a length within said coherence range;

(d) altering said pathway of said object beam so that said object beam is coincidence on a photosensitive surface at a plurality of different angles, wherein said object beam interferes with said reference beam on said photosensitive surface to form diffraction gratings for each pixel.

78. The method of claim 77, wherein each selected pixel is exposed to a plurality of interferences between said reference beam and said object beam.

79. The method of claim 77, wherein said reference beam is coincidence with said photosensitive surface at a 90' angle.

80. An apparatus for converting image data into a hologram formed from diffraction gratings based upon pixels representative of said image, comprising:

(a) means for inputting image data for each pixel representing said image;

(b) a laser source configured to generate a beam with a coherence length suitable for forming a hologram;

(c) an optical system arranged to split and direct said laser beam into a reference beam and at least one object beam along pathways having a length within said range of said coherence length;

(d) means for moving said photosensitive surface with respect to said laser beam; and

(e) a controller, said controller comprising:

means for controlling the radiation of said photosensitive surface on a pixel-by-pixel basis.

81. The apparatus of claim 80, wherein said optical system comprises a rotating head arranged to change the angle of incidence of said object beam according to rotational positioning of said rotating head.

82. The apparatus of claim 80, wherein said means for controlling irradiation comprise:

(i) means for generating control signals to control modulation of said reference and object beams in accordance with image data for each said pixel;

(ii) means for generating control signals to change angles of incidence of said reference beam and said object beams on said photosensitive surface so that each said angle of incidence corresponds to image data for a selected pixel; and

(iii) means for generating control signals to control said means for moving said photosensitive surface in accordance with pixel location as defined in an X-Y coordinate system.

83. A method of converting an image into a hologram formed from diffraction gratings, comprising the steps of:

(a) obtaining pixel data of said image;

(b) manipulating a laser beam according to pixel data characteristics;

(c) irradiating a photosensitive surface with said manipulated laser beam to form interference patterns on a pixel-by-pixel basis, said interference patterns of each pixel being characteristic of image data of corresponding pixels of said image.

84. The method of claim 83, further comprising the step of:

(d) adjusting distances between adjacent pixels to control apparent location of an image generated by 5 reflecting light from said hologram.

85. The apparatus of claim 80, wherein said optical system comprises:

a beam splitter cube;

a mirror arranged at a 451 angle to said reference beam; and

means for moving said mirror with respect to said beam splitter.

86. The apparatus of claim 85, wherein said optical system further comprises a second mirror arranged at a 45° angle to said reference beam, where said second mirror is split into a first portion and a second 5 portion, said first portion being fixed and said second portion being movable; and

means for moving said second portion to variably redirect light reflected

from said first mirror.

87. The apparatus of claim 80, further comprising means for determining the deviation in an actual laser beam path from a desired laser beam path.

88. The apparatus of claim 87, wherein said means for detecting comprises a second laser source;

a mirror having an opening;

a focusing lens; and

a sensor connected to said controller.

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